Arthropoda Selecta 14 (4): 291–296 © ARTHROPODA SELECTA, 2005

SEM mouthparts morphology of four amphipod species — dwellers of red algae beds in the White Sea

Морфология ротового аппарата четырех видов амфипод — обитателей зарослей красных водорослей Белого моря, изученная с помощью сканирующего электронного микроскопа

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KEY WORDS: Amphipoda, red algae beds, mouthparts morphology, food preferences.

КЛЮЧЕВЫЕ СЛОВА: разноногие раки, заросли красных водорослей, морфология ротового аппарата, пищевые предпочтения.

ABSTACT. Study of mouthparts microstructure by SEM indicates differences at food preferences of amphipods, which inhabit red algae beds in the upper subtidal zone of the Kandalaksha Bay (the White Sea). The mouthparts of *Ampithoe rubricata* (Montagu, 1808) (Ampithoidae), *Gammaropsis melanops* Sars, 1879 (Isaeidae), *Sympleustes glaber* (Boeck, 1861) (Pleustidae) adapt to grazing, while *Crassicorophium bonelli* (Milne-Edwards, 1830) (Corophioidea) has deposit-suspension type of food apparatus.

РЕЗЮМЕ. Изучение микроструктуры ротового аппарата с помощью сканирующего электронного микроскопа показывает различия в пищевых предпочтениях амфипод, населяющих заросли красных водорослей в верхней сублиторали Кандалакшского залива (Белое море). Ротовые конечности *Ampithoe rubricata* (Montagu, 1808) (Ampithoidae), *Gammaropsis melanops* Sars, 1879 (Isaeidae), *Sympleustes glaber* (Boeck, 1861) (Pleustidae) приспособлены для разгрызания, в то время как *Crassicorophium bonelli* (Milne-Edwards, 1830) (Corophioidea) имеет фильтрующий тип ротового аппарата.

Introduction

In recent years, the ever increasing availability of precise microscopic observation techniques has considerably influenced the study of the crustacean micromorphology. The method of Scanning Electron Microscopy (SEM) proved useful to study morphology and present illustrations of external morphological details of small arthropods. In particular, in the amphipod studies this approach was focused on details of surface microstructure [Halcrow & Bousfield, 1987]. However, mouthparts are traditionally illustrated using mostly light microscopy and drawing techniques. This study focuses on mouthparts appendages (mandible, maxillule and maxilla), which show varying morphology possibly reflecting the feeding mode. The objective of the present study is interpretation of feeding preferences of four common amphipod species, which inhabit the red algae in the subtidal zone of the White Sea on the basis of the SEM study of their mouthparts.

Materials and methods

Specimens of amphipods from the red algae were collected at the White Sea Biological Station (Kandalaksha Bay), Russia, in August 2003 in the following areas: near the biological station, at Kindo Cape, near Eremeevsky and Kokoicha Islands using SCUBA (at depths from 1 to 13.6 m). Interestingly, *Gammaropsis melanops* Sars, 1879 and *Sympleustes glaber* (Boeck, 1861) were collected mostly from algae covered by sponges, the other species, *Ampithoe rubricata* (Montagu, 1808) and *Crassicorophium bonelli* (Milne Edwards, 1830) were found mostly on noncovered red elgae. Four species inhabited red algae without selection and they could be found on different species of red algae. At each place, algae species were sampled by SCUBA diving using the hand-net method (different species of red algae were picked up separately). They were transported as dried samples. Algal species were as follows: *Ahnfeltia plicata* (Huds.) Fries., *Euthora cristata* (Lyngb.), *Odonthalia dentata* (L.) Lyngb., *Phycodrys* sp., *Phyllophora interrupta* (Grev.) J. Ag., *Ptilota plumosa* (L.) Ag. Amphipod crustaceans were sorted to species and preserved in Eppendorf tubes with 8 % formalin, they were identi-

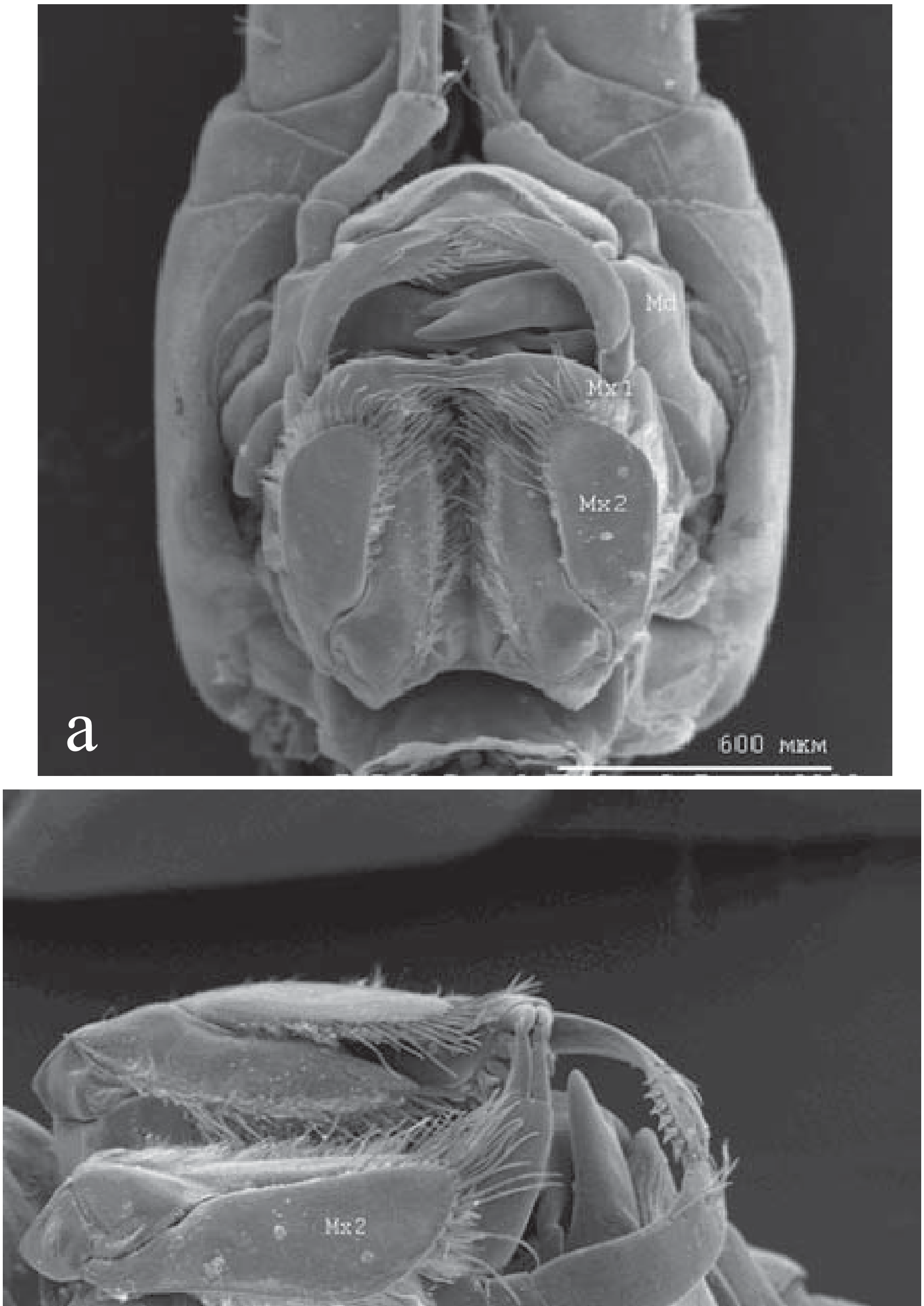


Fig. 1 (a, b). SEM-graphs of the mouthparts of *Ampithoe rubricata* (Montagu, 1808): a — ventral view; b — ventrolateral view.

Рис. 1 (a, b). Электронные микрофотографии (SEM) ротового аппарата *Ampithoe rubricata* (Montagu, 1808): a — вид с вентральной стороны; b — вид с вентролатеральной стороны.

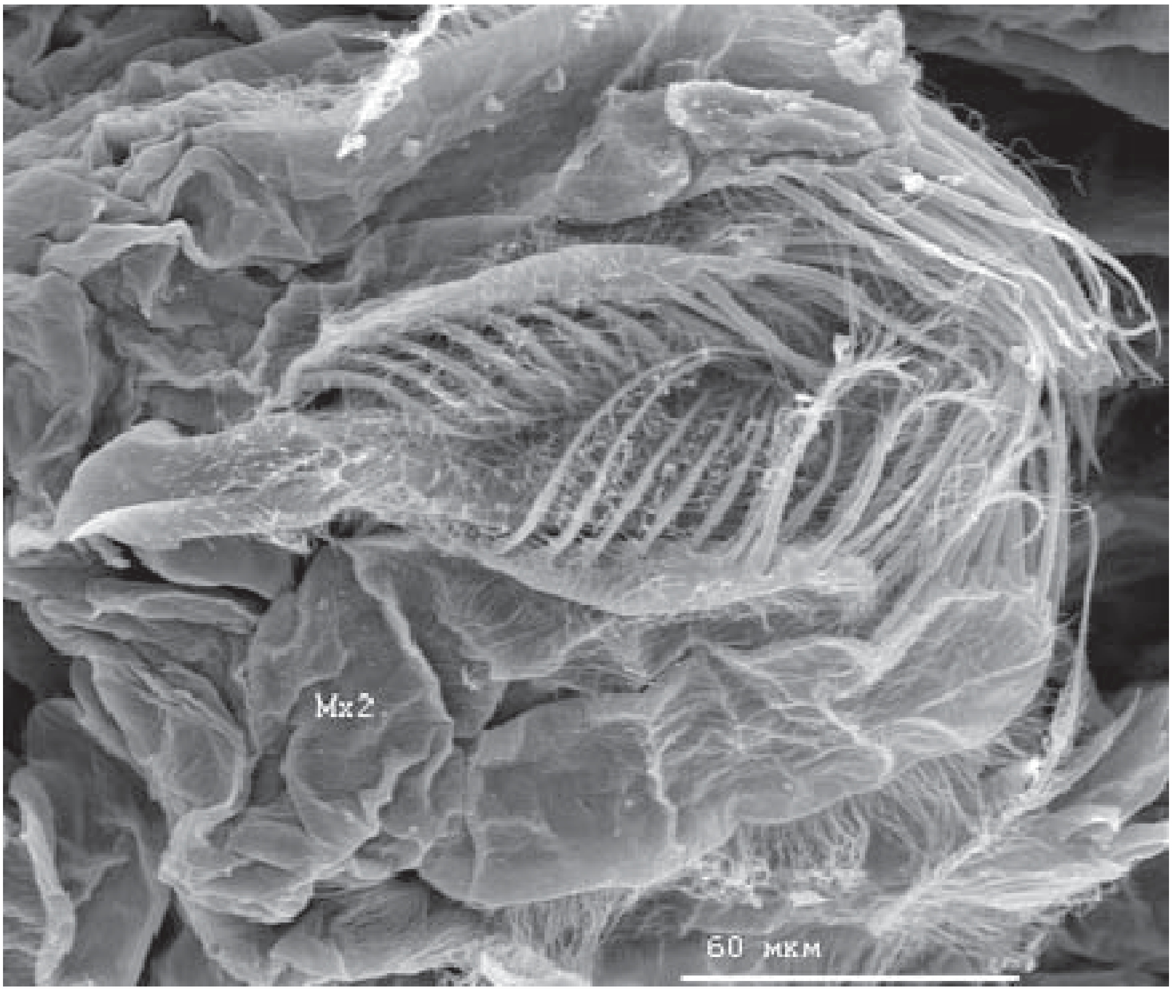


Fig. 2. SEM-graph of the mouthparts of *Crassicorophium bonelli* (Milne Edwards, 1830), ventral view.

Рис. 2. Электронная микрофотография (SEM) ротового аппарата *Crassicorophium bonelli* (Milne Edwards, 1830), вид с вентральной стороны.

fied according to Gurjanova [1951], Barnard & Karaman [1991], Martin & Davis [2001].

Samples for SEM observation were held in ethanol, dehydrated in acetone and dried with CO_2 the critical point method. Dried specimens were sputter coated with gold and finally examined with a HITACHI S405A scunning electron microscope at the Laboratory of Electron Microscopy of the Moscow State University, Russia.

List of abbreviations: md — mandible, mx1 — maxillule, mx2 — maxilla.

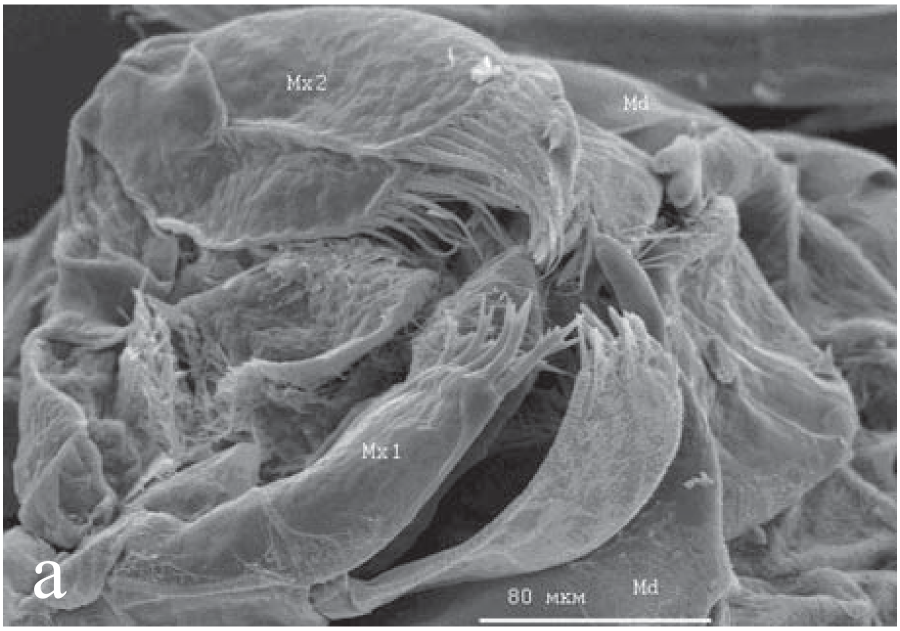
Results

Ampithoe rubricata (Montagu, 1808)
Fig. 1.

The specimens (total length ca. 14.5 mm) show good preservation of the mouthparts. Mouthparts are compact: mx1 set on some distance from md and extends beyond it, mx2 set close to mx1. Mandibles with incisor processes long, sharp, and with 5 to 6 large denticles; palp 3-articulated, distal article large, expanded, asymmetrical, with a great number of setae on the top (Fig. 1a, b). Maxillule has 2-articulated palp with 10 strong apical setae. Outer plate of maxilla tapering distally, longer than inner plate, with long setae on oblique anterolateral margin; inner plate with rounded apex and setae on medial margin.

Crassicorophium bonelli (Milne Edwards, 1830)
Fig. 2.

Generally accepted treatment for SEM examination apparently affected the material and led to some deformation of the mouthparts due to the thin cuticle of the *Corophium* specimens. Mouthparts lie in one plane, setae are directed inside. Incisor processes of mandibles with denticles, palp 2-articulated, 2nd article with short setae on lateral margin, both articles bears also feathery setae (Fig. 2). Palp of maxillule 2-articulated with several strong setae on the top. Maxilla has numerous feathery setae on meso-apical margin of inner plate and apical margin of outer plate; inner plate shorter than outer one.



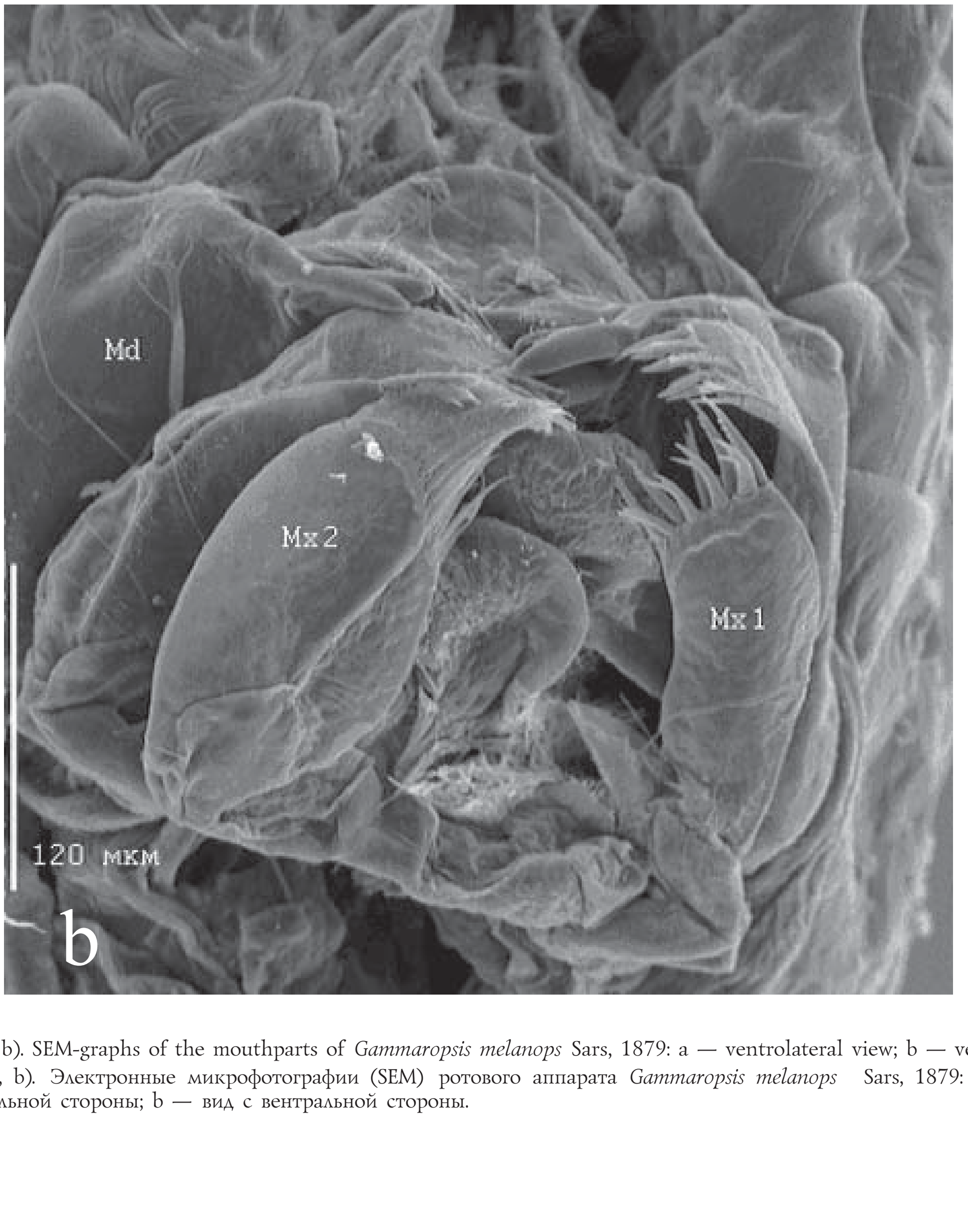


Fig. 3 (a, b). SEM-graphs of the mouthparts of *Gammaropsis melanops* Sars, 1879: a — ventrolateral view; b — ventral view.

Рис. 3 (a, b). Электронные микрофотографии (SEM) ротового аппарата *Gammaropsis melanops* Sars, 1879: a — вид с вентролатеральной стороны; b — вид с вентральной стороны.

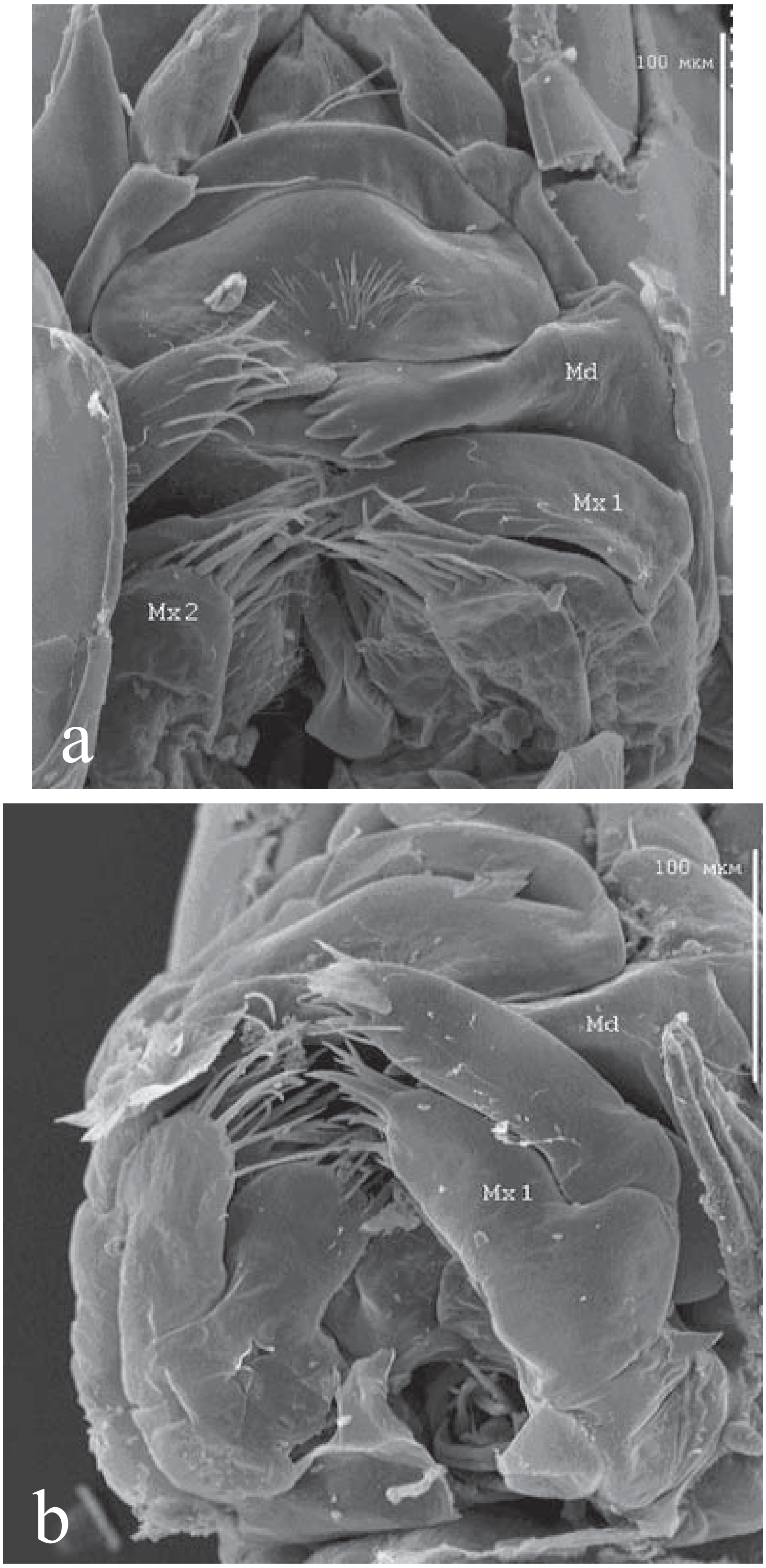


Fig. 4 (a, b). SEM-graphs of the mouthparts of *Sympleustes glaber* (Boeck, 1861): a — ventral view with removed mx2 on the rigth side; b — ventrolateral view without mx2 on the rigth side.

Рис. 4 (a, b). Электронные микрофотографии (SEM) ротового аппарата *Sympleustes glaber* (Boeck, 1861): a — вид с вентральной стороны с удаленной mx2 справа; b — вид с вентролатеральной стороны без mx2 справа.

Gammaropsis melanops Sars, 1879
Fig. 3.

Mouthparts have smilar size, closely set, but apical parts of them are not lying in the same plane. Mandible has incisor process with denticles, well-developed palp 3-articulated with long tough apical setae (Fig. 3a, b). Maxillule has typical morphology, but its palp bears numerous short setae on the distal part, apical setae with additional denticles. Inner and outer plates of maxilla equal in size, bearing numerous long and strong apical setae.

Sympleustes glaber (Boeck, 1861)
Fig. 4.

Mouthparts are very compact: mandible, maxillule and maxilla are flat, set very close to each other. Incisor of mandible with 5 denticles, palp 3-articulate, second and third articles have 5–6 setae on medial margin and one long apical setae (Fig. 4a, b). Maxillule with strong setae on the top of palp, inner plate with 5 serrated apical setae. Outer and inner plates of maxilla have the same size and rounded apex with 6 long apical setae.

Discussion

Method of SEM observation appears to be appropriate for the amphipod species with thick integument, such as *Ampithoe rubricata, Gammaropsis melanops* and *Sympleustes glaber*. Another species, *Crassicorophium bonelli,* has thin cover, which easily can be damaged. Thus it is necessary to develop a special gentle procedure in order to preserve the cuticle from deformation. Probably, it needs more gradual increase of ethanol concentration (with difference approximately 7%).

Ampithoe rubricata and related species from other areas (*A. helleri* Karaman, 1975; *A. ramondi* Audouin, 1826) are known to feed on various algae [Skutch, 1926; Scipione, 1999]. We suppose that mandibles, which have sharp margins of the incisor process, are responsible for cutting of algae parts; maxillule and maxilla rake up and hold on to cut algae material. These mouthparts work mostly in one plane like a lawn-mower. Thus morphology of the mouthparts confirms the food habit of the *Ampithoe* species revealed by earlier research.

Representatives of the genus *Crassicorophium* are considered as typical deposit-suspension feeders [Scipione, 1999]. According to other studies this species feed on suspended particles filtering them from bottom layers [Icely & Nott, 1984]. Presence of long setae, structure of mandible, maxillule and maxilla may be interpreted as functional morphological characteristics required for capturing small food particles.

There are no observations on feeding of *Gammaropsis melanops*. Since its mouthparts appear similar to those of *A. rubricata* we assume the species to be mostly grazers. However, another species of the genus, *Gammaropsis palmata* (Stebbing et Robertson, 1891), from *Posidonia oceanica* beds in the Mediterranean Sea, is considered to be a deposit-suspension feeder [Scipione, 1999]. Noting that our specimens were associated with sponges-covered algae we suppose that their mouthparts are suited to tackle with incrusted algal surfaces: their apical parts are distant from each other so it can help to reach algae surface more effectively. Thus, mandibles penetrate through sponges and than they gnaw algae, apical parts of maxillule and maxilla direct towards substrate and they hold these gnawed pieces of algae. Probably they can feed on sponges and epifauna.

Sympleustes glaber has the mouthparts constructed similar to *Ampithoe rubricata:* compact setting probably helps to have better access to algae noncovered with sponges.

ACKNOWLEDGEMENTS. I'm extremely grateful to D.G. Zhadan for the help in collecting material. It is a pleasure to acknowledge A.Yu. Sinev for his consultations on SEM. I wish to express my deep gratitude to Dr. V.A. Spiridonov for valuable advices and inspiring me with his enthusiasm. I thank N.S. Mugue for constructive criticism on this paper.

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